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DEFENSE SYSTEMS MANAGEMENT COLLEGE

PROGRAM MANAGEMENT COURSE
INDIVIDUAL STUDY PROGRAM

-SNAP-
SIMPLIFIED NETWORK ANALYSIS PORTRAYAL
FOR PLANNING AND CONTROL

STUDY PROJECT REPORT
PMC 77-1

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FORT BELVOIR, VIRGINIA 22060

SNAP

SIMPLIFIED NETWORK ANALYSIS PORTRAYAL for PLANNING AND CONTROL

Individual Study Project

Study Project Report

Prepared as a Formal Report

Defense Systems Management College

Program Management Course

Class 77-1

by

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March 1977

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LCDR Susan H. Anderson

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

REPORT DOCUMENTATION PAGE		READ INSTRUCTIONS BEFORE COMPLETING FORM
1. REPORT NUMBER	2. GOVT ACCESSION NO.	3. RECIPIENT'S CATALOG NUMBER
4. TITLE (and Subtitle) -SNAP- SIMPLIFIED NETWORK ANALYSIS PORTRAYAL FOR PLANNING AND CONTROL		5. TYPE OF REPORT & PERIOD COVERED Study Project Report 77-1 6. PERFORMING ORG. REPORT NUMBER
7. AUTHOR(s) KENNETH N. BROWN		8. CONTRACT OR GRANT NUMBER(s)
9. PERFORMING ORGANIZATION NAME AND ADDRESS DEFENSE SYSTEMS MANAGEMENT COLLEGE FT. BELVOIR, VA 22060		10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS
11. CONTROLLING OFFICE NAME AND ADDRESS DEFENSE SYSTEMS MANAGEMENT COLLEGE FT. BELVOIR, VA 22060		12. REPORT DATE 77-1 13. NUMBER OF PAGES 45
14. MONITORING AGENCY NAME & ADDRESS(If different from Controlling Office)		15. SECURITY CLASS. (of this report) UNCLASSIFIED 15a. DECLASSIFICATION/DOWNGRADING SCHEDULE

16. DISTRIBUTION STATEMENT (of this Report)

UNLIMITED

DISTRIBUTION STATEMENT A
Approved for public release;
Distribution Unlimited

17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)

18. SUPPLEMENTARY NOTES

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

SEE ATTACHED SHEET

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

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DD FORM 1 JAN 73 1473 EDITION OF 1 NOV 65 IS OBSOLETE

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

DEFENSE SYSTEMS MANAGEMENT COLLEGE

STUDY TITLE:

SNAP-Simplified Network Analysis Portrayal for Planning and Control

STUDY PROJECT GOALS:

To categorize in comparison to other network techniques a simplified approach that has been used successfully in the past. To report the experiences with the technique. To set rules for its future use and to suggest areas of expanded utility.

STUDY REPORT ABSTRACT:

Network techniques are widely used to assist the manager in understanding, planning, and controlling complex projects. The more complex approaches such as decision-risk analysis and PERT/CPM explore alternatives and deal with interactions. The simple and easy techniques like the Gantt Chart tend to be linear. Any complex enterprise must consider alternatives and interactions, but there is virtue in simplicity.

This report explores a simplified network analysis approach which gives special consideration to evaluation as part of the process of achieving objectives. It capitalizes on the idea that evaluation results in a decision, and that in turn, this gives visibility to alternatives. The technique can be tailored to the level of management and the task addressed by the manager/network-user.

Experience with two major tasks within different Army projects is related to show how the technique was applied. The future application is explored by codifying the technique with regard to its basic considerations and mechanics and by suggesting the scope of its utility.

KEY WORDS: Network Analysis, Planning and Control, Project Management

NAME, RANK, SERVICE	CLASS	DATE
Kenneth M. Brown, MAJ, USA	PLC 77-1	March 1977

EXECUTIVE SUMMARY

Network techniques are widely used to assist the manager in understanding, planning, and controllong complex projects. The more complex approaches such as decision-risk analysis and PERT/CPM explore alternatives and deal with interactions. The simple and easy techniques like the Gantt Chart tend to be linear. Any complex enterprise must consider alternatives and interactions, but there is virtue in simplicity.

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ACKNOWLEDGMENT

The constructive criticism and helpful suggestions provided by Lieutenant Commander Susan H. Anderson, United States Navy, of the Defense Systems Management College, Fort Belvoir, Virginia were essential to the completion of this report.

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SECTION I

INTRODUCTION

The essense of program management is getting to the program objective through the use of resources. Aspects of interest are the functions performed in doing it, the phases through which the program proceeds, and the framing organizations within which the functions are done. When all is said and done, however, the successful manager must see that some piece of work is performed well, completely, efficiently, and on time.

Modern managers study and use complex techniques for planning, organizing, directing, and controlling the performance of many, many pieces of work for which they are accountable. One category of these modern techniques is network analysis. Gantt Charts, PERT networks, and decision-risk trees are in this category. Almost every program management office has some graphical network, if you will a picture, of the events which have taken place, are on-going, or are expected. Often, a macrostructure of singular, important items of concern is portrayed. The steps which get the program from important item "one" to important item"two", the next level of pieces of work,are allocated to the next lower level of managers.

As the level decreases, the managers become more and more functionally oriented. Engineers, for example, often perform a dual role as manager and functional operator. Planning and control of their piece of work may well have low priority relative to the hands-on task of today. It may not be efficient to apply the complex analysis to these pieces of work, but some future oriented outlook is needed.

For want of a nail, after all, a kingdom can be lost. Each piece of work should be visible and traceable within its own and the program framework. The program bounds each piece of work with time and other resources and with other major program events. A view of all this with especially good visibility and traceability is provided by the graphical network. Experience and success in managing two significant pieces of work at the managing-engineer level have shown me that there is a simple, useful, graphical network which can be set up and used for planning and control.

It is worthwhile to explore this technique, to more clearly define it, and to relate the experiences mentioned. General rules for using the technique will allow others to adopt it.

This report will explain the simplified network analysis and portrayal (SNAP) for planning and control aspects of management. What it entails, where it fits in a spectrum of network techniques, and what its utility may be will be discussed.

Some words of warning are in order at the outset. The word management has many meanings. The reader is expected to apply his own contextual perceptions where that word appears. Peter F. Drucker's book, Management: Tasks, Responsibilities, Practices is very useful in expanding perceptions of what management is(7: 1-48).*

The reader looking for some new sophisticated technique won't find it here. There may well be too much impractical sophistication, anyway. Presented are some ideas which helped turn two impending disasters into authentic successes. The ideas are simple, but not

* This notation will be used throughout this report for sources and references. The first number is the source as listed in the bibliography; the second is the page or pages in the source referenced.

simplistic. The reader who wants to know how to get a job done where the "rubber meets the road" will be satisfied.

Finally, the pronoun "he" will be used with no connotation of sex discrimination. For lack of a better word, please accept the fact that "he" means "he or she".

SECTION II

OVERVIEW OF NETWORK TECHNIQUES

Graphical techniques are easily defined as those which portray a process in the form of writing and drawing. The dictionary also indicates that being graphical implies a degree of clarity and sharpness. There is nothing which limits the idea of graphical technique to the discipline of management.

Networks, in general terms again, are series, chains, or groups of things which are interrelated and often interconnected in some fashion. Networks,as they may be addressed to management,may be entirely abstract. That is to say, people who carry out the process of management must have some idea of how what they do relates to other things going on around them in the management environment. The problem is that if these ideas are not taken out of their abstract state so that they become understandable, the manager may continually wallow in a swamp of erroneous perceptions of what is really happening.

Gantt, with his sequence charts, was the first to give some structure to the interrelationships of actions needed to accomplish an objective. His abstraction of the network of steps was developed by projecting the reverse sequence of events and their timing(7:182). Of significance was his idea to portray this projection as a bar chart. The bar length in general represents the time consumed in carrying out each step.

The Gantt Chart is the most common graphical technique used in modern management. It is probably the easiest to understand and to construct and that is certainly why it is so widely used.

More recently, Cantt's ideas have been greatly extended. More and more complex programs, that is groups of tasks leading to an objective, challenge the manager. To get a handle on them, modern management approaches such as the Program Evaluation and Review Technique(PERT), the Critical Path Method(CPM), and network analyses in other forms have been developed. These are all extensions of Cantt's ideas (12:461).

The bar chart introduced by Gantt had the basic elements of all graphical network techniques used in management. It portrays activities needed to obtain required end results. It shows how tasks and actions are linearly interrelated and interconnected. Finally, it is a chart, a picture, as opposed to just a word description. These points are all essential, but remember that the rationale or abstraction which preceeded the drawing of the chart must be kept in mind.

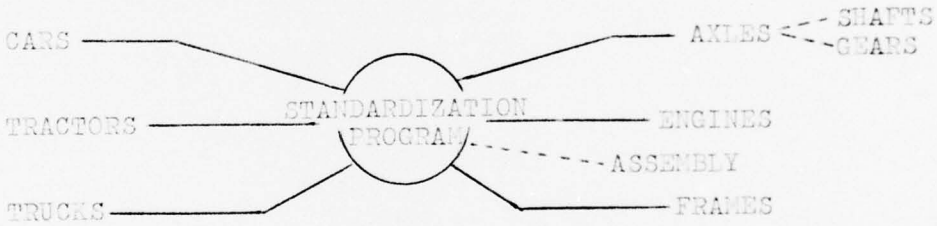
As mentioned, a spectrum of extensions of the concept of rationalizing abstract perceptions has been introduced in just the last twenty years. This was in response to increasingly complex programs with which managers had to deal (13: 127-132). These extensions are applied to the planning and control functions of management (12: 461). Gantt's graphics were essentially one dimensional or linear. This tends to drive one's view so that activities are seen one after another. The only interrelation is that one must be done before the next can begin. The extensions, among other variations, added more dimensions; so that concurrent activities could be readily incorporated into the network. More careful

analysis of interrelationships was possible and estimates for the time duration of activities were included(1: 12-15).

The more complex network techniques fall into a group which is often designated PERT/CPM. PERT deals with events or milestones. It projects when an action will start and when it will be completed. It shows clearly the key points in time and whether or not dependent events can occur. CPM orients on activities which are the actions that take place between events (1:14). There are very specific rules for how these techniques are set up and used. And, there are methods by which computer support facilitates their use (1: 16-22). These techniques have limits on how much they can tell the manager. There has been a tendency away from the use of PERT/CPM, because managers have lost faith in them as useful tools. This is thought by some to be caused by an over-extension of the methods to the point where managers expected too much. PERT/CPM was not and could not have been the window which allowed light to fall upon and dispell all uncertainty (8:49). Be that as it may, PERT/CPM is a not-too-simple-not-too-complex approach for gaining insights into complex programs, especially in research and engineering efforts.

The graphic portrayal used in connection with all network techniques lends a degree of starkness to them. Appearing clear and absolute, a network may often be assumed to be completely objective. But,it has been suggested that the rationale behind the network is critical,and it is now suggested that the media is not necessarily the message. There are techniques which use subjective network analysis to describe management interactions.

The Systematic Planning for Integration and Direction of Engineering and Research technique(SPILERCHART) is one example of this type of subjective analysis (5:26-27). In this technique a double tree grows from the center point of the chart, the center being the program under consideration. On one tree, all the generic systems which relate to a program are shown. The other tree would show the component parts of the program which contribute to the generic side through the program. For example, an automotive manufacturer may wish to increase standardization of components used in several end items. The generic tree would show types of end items such as cars, trucks, and farm tractors. The other tree would show such things as engines, axles, and frames. In the center the connector is the standardization program which, of course, involves integration and direction. By drawing the SPIDERCHART as follows:



...insights can be gained into what is involved. One thing that comes to mind is that "ASSEMBLY" production procedures may be subject to standardization. This is added as a component. Another point is that the "AXLES" component may be separated into other components like "SHAFTS" and"GEARS". These may be more easily standardized. This shows how a SPIDERCHART may be used. When interpretation is considered, this technique can become quite complex depending on the program. This technique seems to have great value as a tool to be

used in the integration functions of management. The capacity of the SPIDERCHART analysis to provide insight into the breakout of program subelements assists the manager in balancing efforts.

It is now necessary to return to the more objective network techniques in order to complete the overview. In a spectrum of network types, Gantt Charts are on the simple end. PERT/CPM and the SPIDERCHART are in the mid-range of complexity. What technique, then, describes the most sophisticated of network forms?

If the problem and the mathematical methods used are considered, the decision-risk analysis and its associated trees set this upper bound on complexity. Both the bar chart and the PERT/CPM family of techniques assume success of each event. Thus, work proceeds as expected and each step is taken as planned. Unfortunately, complex and even simple programs are never absolutely assurable. The decision tree is a network which projects the likelihood of a given outcome by following a path of decisions and accumulating the effects of risk (2:13-57). Given a desired outcome and the risks of each step leading to it(in terms of probabilities), the manager can assess the uncertainty he faces. From another viewpoint, he may be able to see the other possible outcomes of his decisions or of turns-of-event(3:276-281).

Decision-risk analysis and decision trees require the use of statistical analysis and other well defined mathematical skills in all but the very simple cases. The construction of the tree is not an easy task, and so it is used only for more critical programs where the special resources needed are affordable.

A brief look at what level of manager uses the various techniques is of value at this point. Remember, we are dealing with methods of clarifying someone's abstract thoughts on how actions leading to an objective are to be accomplished. In planning and control the basic questions are: What must be done? How long will it take? What are the interactions and impacts? What resources are needed and so on? Gantt Charts are flexible in that they are simple to prepare and understand. Their use can be adjusted to any level of management to meet overview or detailed needs. PERT/CPM, in contrast, deal with events and activities in a more complex way. They are useful and practical at a level of management which is concerned with sufficiently complex systems needing consideration of interactions.

PERT/CPM analysis requires the application of special expertise and takes some amount of time to implement. Decision trees take even more time and require more expertise for both implementation and interpretation. Thus, programs using decision-risk analysis are usually complex. The manager who directs their use must have control of sufficient resources so that the proper expertise is brought to bear. Never-the-less, interpretation and use of the results may be left to the lower levels of management where details are of concern.

The implications of the past several paragraphs can be summarized on a contiuum which compares a few of the currently recognized network techniques. This has been done in Figure 1 on the next page. Many other techniques have been developed and documented (17:10-18 and 16: 2-1 to 4-14).

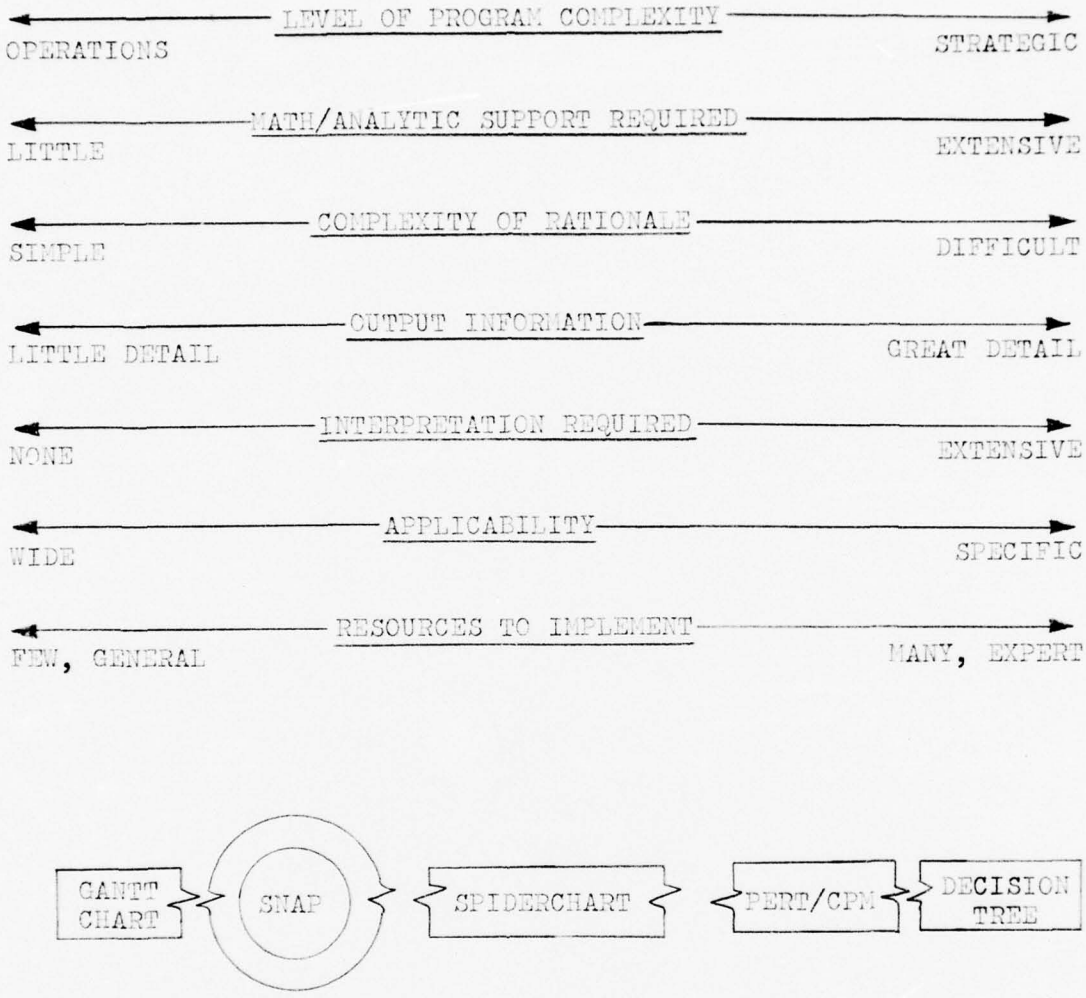


FIGURE 1

THE NETWORK TECHNIQUES SPECTRUM

NOTE: The idea of dealing with various dimensions of management concepts has been widely applied by Professors Fred Ascani and Andy Low of USC. It allows comparison of variables(often thought to be discreet) on a continuum.

On Figure 1 the SNAP technique has been enterred on the simple end of the spectrum. The reasons for this shall become clear as we proceed, but it serves to keep the location in mind.

That the complex techniques require exten ive expertise and substantial input is not a criticism of them, but it does imply that their application is not always practical or feasible. There is real value in keeping your tools as simple and rugged as possible. The needs of a manager and the techniques he employs are closely related to the level at which he functions be it strategic, coordinative, or operating(12:119-123).

Any level could use to some extent any of the spectrum of network techniques which have been described. An important consideration which follows from this is how far the user and preparer of a network are separated in or within the levels. When separation in time, space, or level dilutes knowledge of the rationale and its limitation, dangerous misinterpretation is possible. Of some concern is the implication of factuality which is attributed to the graphic presentation. A simple technique allows the user and preparor to be the same person. In the next section, two examples will be introduced to describe better the level of application of SNAP. This will allow the explanation of the simplified non-linear approach within a framework of application which is after all the eye of the beholder approach.

SECTION III

DESCRIPTION OF S*N*A*P

Consider now two military projects, both managed by chartered project managers(PM). One project will eventually produce a new air defense missile system, while the other will produce a modern and more efficient ammunition production base.

The air defense system is in the advanced development stage of the acquisition cycle. Hardware concepts are being proven in the "brass board" mode. Successful accomplishment of seven critical milestones will allow the PM to proceed into full development. One of these milestones is the successful completion of flight testing of an experimental model guidance system. The tests are to begin soon and will be accomplished by a systems contractor. The milestone of concern to the PM is to be completed fifteen months from this point. The PM has assigned an engineer to manage the testing for him within his organization. Because of the visibility of the seven milestones, success to include continuous progress is essential to the viability of the project as a whole. The project PERT chart shows two flight test events: START TEST and COMPLETE TEST.

The ammunition production base project is in terms of money and time very large. However, it consists of several smaller projects which apply two general improvements to the existing capabilities. First, new and modern manufacturing technology must be developed and employed. Second, where necessary new buildings and facilities must be built to house these new processes. We enter this project in the area of rifle ammunition. A completely new, highly automated system

for making the ammunition has been designed. Four new machines form a module which takes preformed raw material and powder and makes them into a complete round. Tests on the four sub-modules have been completed and they are being integrated into the complete round process. Work is being supervised by an Army Arsenal(engineering activity) and being done by an ammunition plant operating contractor. This project is the first of the major modernization efforts and its success is essential. Integration has been underway for eight months, but there has been no progress. Failure of the integration at this point in time could endanger the entire modernization program because the rifle ammunition project has high visibility. The ammunition program PM has assigned a special project engineer/monitor to execute the integration through the arsenal and the operating contractor. Three months have been allocated to achieve a successful integration. The PM has only a bar chart portrayal of the ten month integration(Note: The special manager has been given one extra month extension on the original ten month projection.).

These descriptions serve here to show what is meant by pieces of work. It would be possible to define this type of level within any program. One good approach would be to define levels in a work breakdown structure, while another might use the tasks assigned to appropriate work centers. More criteria for levels used in SNAP will be provided later, but any technique application must consider the level of work and management it is intended to aid.

May we not call the engineer and engineer/monitor just described as middle managers? The PM in both cases has assigned a single manager to plan and control activities within a relatively fixed

organizational environment. The PM remains concerned with the achievement of broader objectives within the larger program. The engineer/manager is the middle level executive between the PM and the operational piece of work(12:120).

The problem facing this middle manager is to find out what to do, what resources are needed, and how to accomplish the tasks to get from where he is to the project objectives. The most common first step would be to list tasks and target dates, and perhaps, to develop an Gantt Chart. While this is fine as far as it goes, the analysis assumes a linear pattern...a step-by-step process. The tendency is <u>not</u> to consider the consequences of step failure especially schedule slippages and performance shortfalls.

Linear Gantt Charts do not allow the consideration of alternatives. Alternatives may well include the exploitation of success as the work proceeds. Is there a way to avoid the idea that work is always step-by-step and the idea that the course of activity cannot be altered except by linear extension? Formulation of the course work is to follow in terms of alternatives and contingencies is one way to get a positive answer to this question.

A simple network can show courses of action, much as PERT/CPM does, in terms of activities and events. However, instead of thinking of the end of an activity as an event, it is better to consider it a point of decision. These decisions are more or less an evaluation of success of the activity. Depending on the evaluation and decision, various alternatives may be considered.

To remind again: the network represents the ideas in the mind

of the manager. SNAP expands on the Gantt Chart by considering evaluation, or if you prefer control, and by portraying alternatives which can be taken based on these evaluations. Figure 2, below, shows how PERT, CPM, Gantt Charts, and SNAP compare in general format:

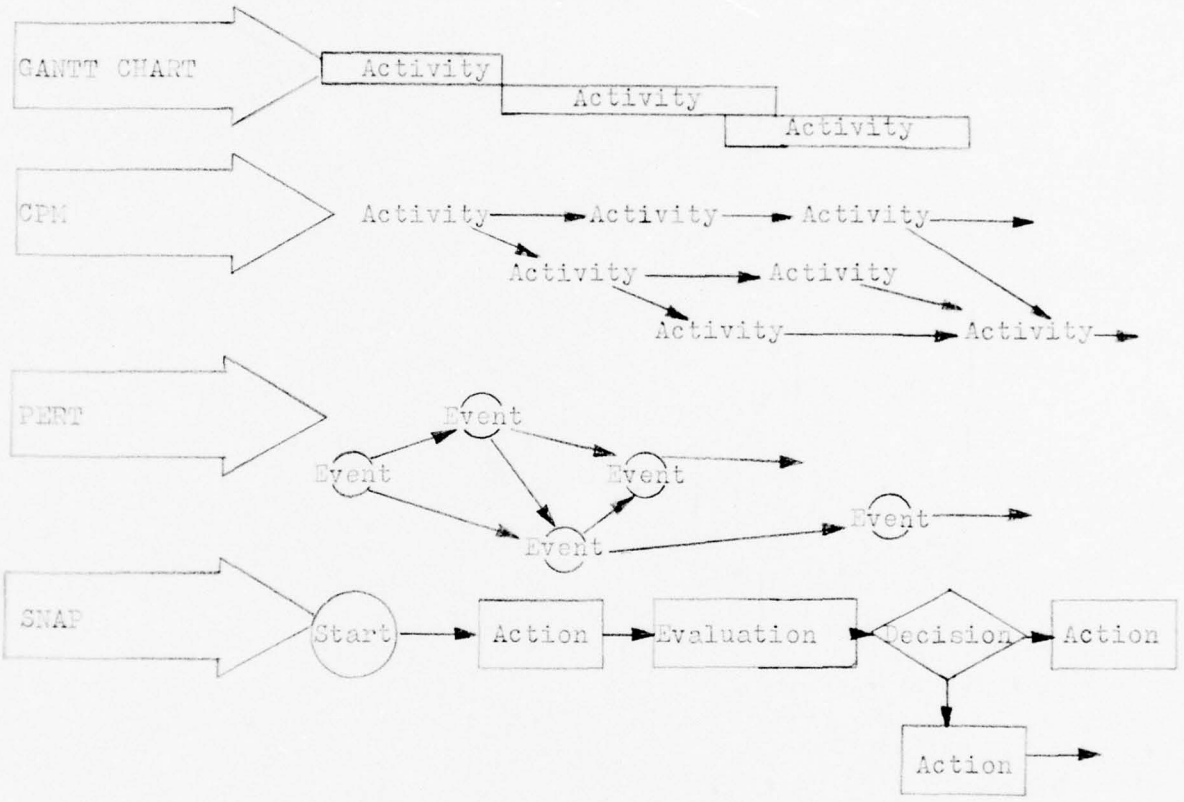


FIGURE 2

NETWORK FORMATS

SNAP resembles the flow chart of a computer program. It reflects alternatives that may be much more than the simple yes or no found in such charts. SNAP portrays efforts being undertaken as they are imagined by the manager in the planning process. It illuminates consequences of problems and opportunities for exploitation.

In drawing the SNAP there are not a great number of conventions to be followed. In general, activities are shown as rectangles and junctions of activities are shown as diamonds. The diamond allows any combination of input and output activities up to four. The output of the diamond is a set of alternatives, so the symbol represents a decision point. Arrows on the SNAP show how activities flow and how they are related. For tracking purposes as work proceeds the network can be annotated in any convenient manner to indicate what alternatives were followed.

When the manager is going through the initial thought processes and planning the course of work, he may not have specific targets for completing each activity. The dates for completing actions or making decisions may be added at any time. Some value would exist, even at the outset, in using the length of the arrows to represent time estimates. This gives more information to the user and takes advantage of the impact of the graphics. Also, long arrows may show that an activity is too general, and such long duration work may need to be broken up into smaller more meaningful pieces.

The advantages of SNAP now become apparent. Linear bar charts have been expanded upon to provide more flexibility. The manager has been challenged to look for more than just the steps he must follow. He has had to consider the control process as well. He should have been able to see more easily possible problems, overlaps, and potentials for exploitable success. He can draw the network himself with little more effort than the bar chart he would have made anyway.

Of real value is the ability to show the SNAP to others. A clear and concise picture of the manager's expanded view on the

course he wants to follow is presented. Levels below and above the manager can see into his mental picture of what has to be done. Consideration of alternatives will be obvious and points of flexibility can be determined quickly.

The decision junctions provide all a view of how progress will be evaluated. Higher level management can expect to be informed on progress and problems at these points. Lower level operators will know that consideration will be given to different courses at these junctions. Thus, new instructions should not come as a surprise.

The middle manager needs insight into what he must accomplish. He then needs to use this insight to plan and control the efforts which are under his cognizance. SNAP is a simple way to better set up, document, and communicate his abstract thoughts.

At this point the reader should not expect to understand fully how SNAP is applied. The two tasks which were outlined at the beginning of this section will be used in relating two SNAP experiences in the next section. These experiences are totally factual and the SNAP's which are included are reproductions of the ones used. Being real these networks are less than perfect and less than academically simple. Looking at the experiences now will prove the practicality. Section V, which follows the experiences, contains an example of a more simple and more perfect application of SNAP.

SECTION IV

EXPERIENCES WITH SNAP

Missile Guidance Tests

Recall the work package consisting of the flight test of the air defense missile system guidance package. The item under test was mounted aboard a "missile" aircraft. Other items in the test system included a "target" aircraft, a ground based radar, and a control computer. The "missile" engaged the "target" and data was collected via telemetry and on-board recorders. Analysis of the data resulted in an evaluation of the guidance design concept. The key output was a certain amount of data which was the minimum considered adequate to predict performance with confidence.

Tests had begun in January 1970, and through July 1970 flights had been made more or less as expected. In several instances, however, data was not useful because of some questionable characteristic. Design changes were already planned through engineering analysis. The project faced a dilemma of modifying the test item and collecting the needed data by April 1971.

In thinking through the process for doing these two things, the project engineer decided to use a flow chart technique. The chart was put together in a few days. It showed the steps of system modification, follow-on flights, and future testing to be done. Alternate courses to include complete redesign of the guidance system were contemplated. It was known that the program could accomplish part of the tests before all modifications were ready. This could be done by doing the "easy" tests with available minor changes. Later, if these

modifications were adequate, more extensive changes would be fabricated and installed. The network showed how these activities would be sequenced and how the tests and data collection could proceed.

Figure 3, on the next page, is the network now called SNAP which was used to plan and monitor the test from July 1970 to April 1971. During the period, the overall project milestone of interest to the PM was pursued and achieved one month ahead of schedule. ONE MONTH AHEAD OF SCHEDULE FOR A MAJOR MILESTONE...unheard of in this project office! More than enough good data were gathered and the analysis showed the guidance concept was sound.

While SNAP was not the sole reason for success in this piece of work, it was recognized that the work was well organized and under tight control. There was unusually excellent teamwork between the government and the contractor, and there was a high degree of confidence that everyone knew what he was to do and in turn knew how to do it. The SNAP was the medium which allowed the manager to rationalize his course of action. The program was not bound by linearity, and it appears that several months were saved by not waiting for all modifications before doing certain permissable tests. Early success in following the SNAP network and the view it gave into the future inspired confidence in the government manager from the contractor team. A good plan and a supportive team effort made for success. SNAP was the tool that created this combination.

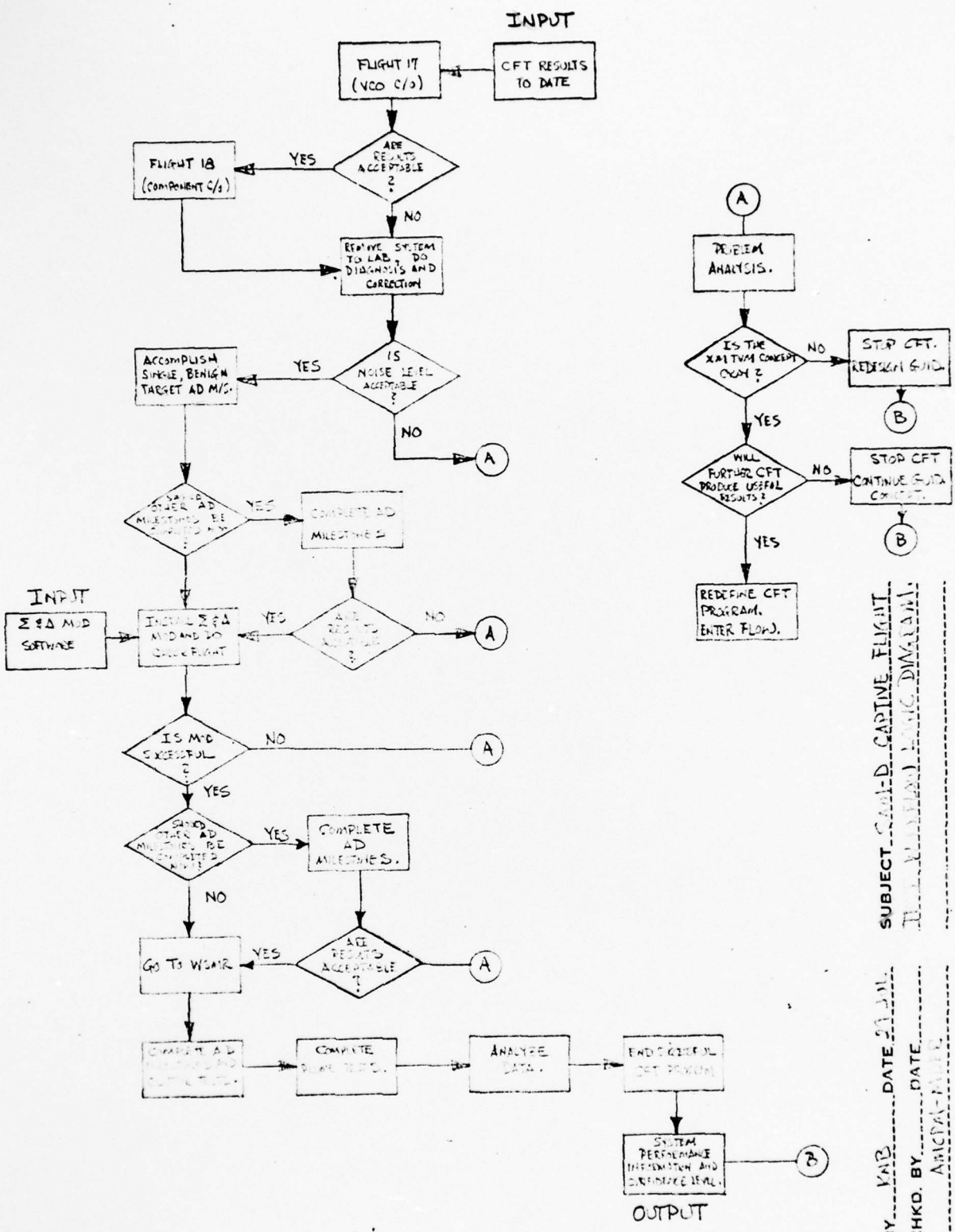


FIGURE 3 MISSILE TEST CHAT

The Production System Integration

Another application of the SNAP occurred in the management of the integration of four prototype ammunition production machines in 1975. Compared to the guidance test, the prototype integration was not as well defined. The time duration of the effort was only three months, August 1975 to October 1975, and was a special constraint.

The objective here was to run four machines which performed different but interrelated functions in proper sequence and at proper rates. Success would be achieved when this module of four machines produced high quality complete rounds at very high rates. Efficient operation of the line required that highly automated equipment be run at these high rates for a sustained period. This translated into six million rounds in a work-month of 21 days.

An integration period of ten months had been allocated. This had been based on the need to make decisions at the end of the ten months for the future use of equipment represented by the prototype. Also, there were limitations on the funds available to support the production workers needed to run the line. Seven months into the ten month work effort the integration had not had any success. The four machines had been run separately, but not together. High rates had not been sustained for more than a few days at a time. No complete rounds of ammunition had been found to be acceptable.

The PM for the overall production base modernization decided to assume direct control in order to quickly prove whether or not the module could operate as required. He obtained a greater commitment of technical resources and assigned his own integration manager.

The immediate objective was to get the module running together as soon as possible and to find the level at which it would operate for a sustained period. Assuming the machines could be integrated by the first of October, then that month would be available to prove that a high rate could be sustained. The management functions to be performed were somewhat limited in that they were concentrated in direction and control. There were few alternatives to the objective with time extremely short. However, it was important to develop a logical flow of activities which would accomplish the integration and would monitor progress very closely.

In thinking out the course to follow, the PM's special manager saw that almost continuous evaluation of the effort and progress was necessary for control. The SNAP for this used the decision diamond to special advantage. The time constraint meant that the established arsenal-contractor team had to be used as is. Also, detailed guidance would have to flow through contract officers and the chain of command; so, too much of that had to be avoided. Figure 4, following this page, is the SNAP used to explain the management approach. Specific dates were included at the outset to tighten down the time valve and prevent any waste.

In this experience the spin-offs from the evaluations were the key to the ultimate success of the project. The September 2 through September 12 checks of plans resulted in new, firm operating strategies; better control of maintenance; more objective quality control; and a well defined production objective. The arsenal engineers quickly realized that the PM's manager meant to achieve

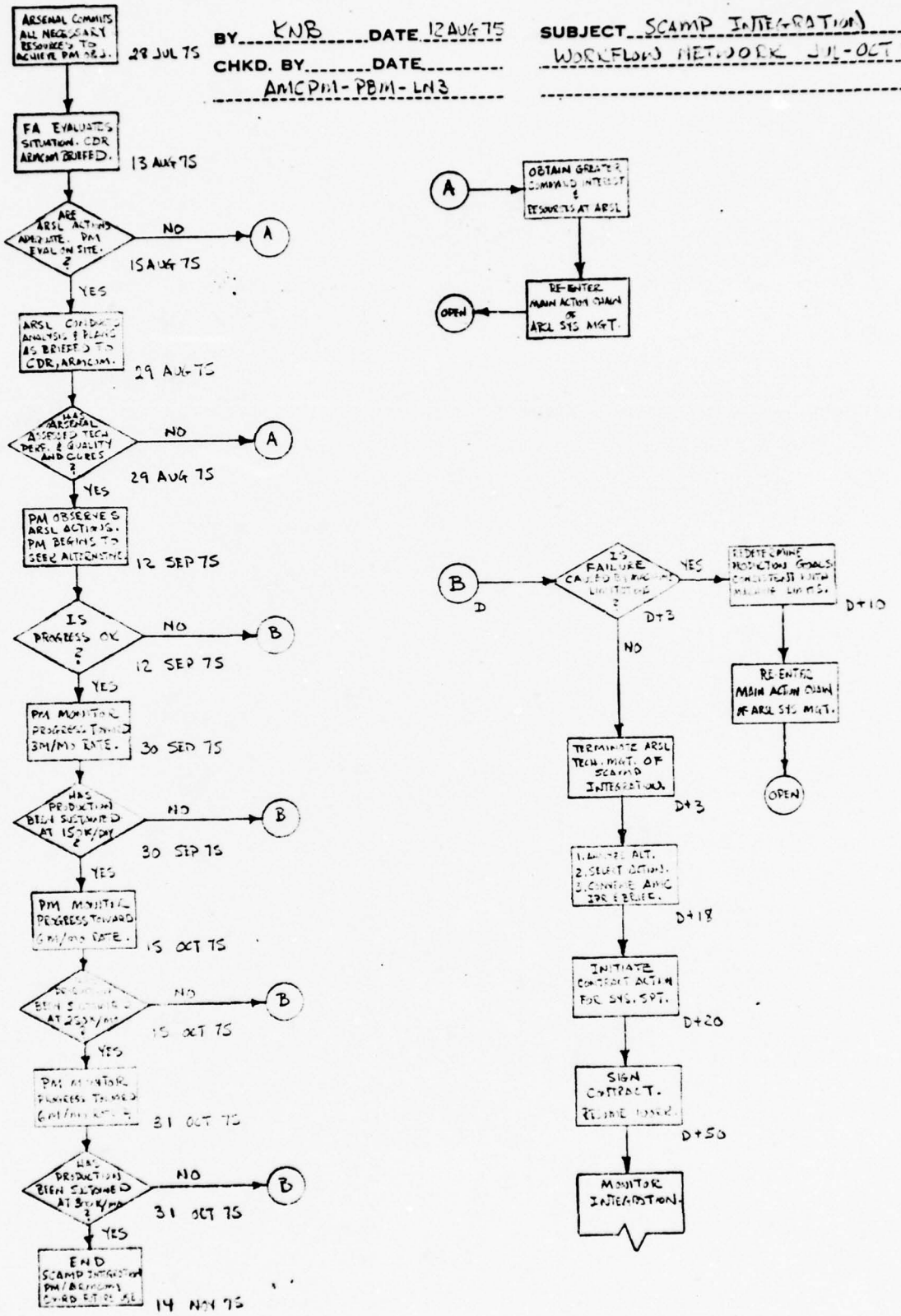


FIGURE 4 PROTOTYPE INTEGRATION SNAP

the objective as long as the machine itself did not prove to be inadequate. By the end of September, there was ample evidence that they were entirely adequate. With this established very close monitoring of operations as prescribed in the SNAP was carried out. Over five million complete rounds of acceptable ammunition were produced in integrated production during October 1975. There were no days during which any machine did not operate. The concept was proven; it could operate at efficient high rates; and operations could be sustained. Confidence in this machine design and in the general idea that modern, automated production techniques could be applied to ammunition manufacture was restored.

The role of SNAP was to show the manager his course of action and to emphasize to all the need for control through evaluation. Motivation was achieved when the only alternative which was available was a drastic realignment of engineering support. The arsenal team was not about to accept the idea of "getting fired".

Another value of SNAP was demonstrated much as it was in the missile guidance test. This was the confidence that came when it became obvious that the SNAP plan was being followed and the task at hand could be accomplished as portrayed. All levels started to trust the special manager. SNAP was the tool that allowed that manager to become the key link in the PM-arsenal-contractor team which, to quote the PM, "turned impending disaster into success".

The two experiences show that SNAP was a useful tool. It was tailored to each use, it was simple, but it had adequate thought behind it. SNAP aids in planning and control, in building confidence,

and in communicating with others.

The question which must now be addressed is about the extended use of SNAP. What are the rules, the mechanics, and the considerations for SNAP? And, what is SNAP's utility in general application? These two questions will be answered in the next two sections.

SECTION V

CONSIDERATIONS AND MECHANICS

The more objective and complex network techniques, even when simplified, have strict rules of use, technique, and application (15:69-70). These rules are manifested in such things as the symbols used. The rules also apply, more importantly, to the analysis and mathematical support which are the basis for the value of these tools. One must not get so entralled with the graphics that he forgets the essense of a good network is the backup analysis and abstract thinking which support it. The bibliography lists sources of rules and rationales for PERT/CPM and decision trees, so the reader whose interest in them is stimulated may find much more detail than has been presented here.

Management is certainly in part an art. Among other implications one can draw from this is that imagination has value to the modern manager. Since a simplified technique is being suggested, tightly constraining rules are not appropriate. Never the less, a few considerations will provide a place to begin for anyone who may want to apply and use SNAP.

It must be emphasized that SNAP as it is being put forth here is not a new idea. The graphics used and the rationale behind them can be found in literature on management processes(13:132). However, the two basic ideas in the approach; the emphasis on evaluation points and the presentation of alternatives, are not so widely seen. Well then, what are the considerations of SNAP?

The first consideration in the SNAP analysis must be the for-

mulation of the actions which must be accomplished to carry out the task at hand. A "zeroth" step is, of course, implied. The user must know where he is within the overall program and to what objective his task is directed. These beginning and end points bound the task the user of SNAP must manage. The term "zeroth" step is appropriate because its input is outside the control of the user.

The idea of bounds on the task gives rise to the question of applicability of SNAP. There are really no bounds on the use of SNAP, although the most simple tasks and the most complex tasks will present too little or too much for SNAP to deal with. Some concepts in applicabiblity can be found by examining the decision diamond. The diamond implies some choice making action. The inputs to the choice and the alternatives which result from it cannot total more than four. If the inputs and alternative actions cannot be represented by the four pointed diamond, then the program under consideration is too broad or too complex. In this case, the user should bring his thinking to a lower level. On the other hand, if there is only one input and one output, there is no choice and no need for the analysis. Caution!!! It may well be that there is more than one input evaluation or more than one output alternative. In this case, the user must elevate and expand his thinking. <u>If there is one point to be made in this paper, it is this one</u>. <u>The process of accomplishing tasks through actions is too often considered to be too simple</u>. Things are too often done because that is the way they have always been done or because the boss likes them that way. Do not dismiss the use of the SNAP because the job is too easy. That

conclusion more likely means you really have not thought about it enough, or else you have some set idea which if examined is not the best, the tailored, approach.

There is no precise level to which this SNAP can be limited. Experiences presented were on the lower side of coordinative management. They dealt with work packages which were well defined in time and by task. The degree of definition of the task may lead one to the use of a network. Again the caution related above applies. Do not fall into the trap of assuming old processes can be used for new tasks or in other words, assuming the task is well defined when it is not. When the task is not well defined, the network may aid in bringing it into focus. When the user wants to take a new look at something thought to be routine, the network is an ideal tool.

To this point the potential user has had to consider where he is now, where he wants to go, and what ideas he has which translate into actions to get him there. From these viewpoints he may resort to a Gantt Chart or milestone chart if he is inclined toward graphics at all. Office rules may even require that he do this. SNAP can be done as easily and it expands these linear approaches greatly. Now consider the end points of each action or step in the series which lead to the objective end point. In terms of the bar chart linear approach these end points are just the bar ends. In the abstraction of the process we may ask how we know we are at the end of a bar. How do we know we have achieved the milestone? The answers come from some kind of evaluation. Normally, when we evaluate we compare what is in-hand, done, or available, with some kind of expectation.

The conclusion drawn from the comparison is that we have met, exceeded, or fallen short of the expected. The respective alternatives for what to do next are: accept the results and continue, exploit success at the higher level and accelerate, or correct the failure and try again. Any linear approach always assumes "accept and continue". SNAP departs from this assumption by concentrating on the choices, the decisions, and thus, allowing the exploitation and correction alternatives to become visible. Since linear approaches are common, it can be assumed that the step one actions of formulating processes and activities will not be too difficult. The transform in SNAP comes when the evaluation of the end points of these actions is considered.

With the project bounds in mind and the process actions cataloged, the next thing to do in SNAP is to choose the evaluation points and the alternative outcomes of the choice process. As the user proceeds through the chain of actions in his process, loops may develop when failure occurs. Hopefully, alternatives for exploitation of an unexpected level of success will also develop. If they do not show up in some way, the basic process may be overly optimistic. As this step in SNAP is carried out the user can expect to return to step one, Action Formulation, since new activities will be uncovered.

Thusfar, three steps in SNAP after the zeroth step of determining the bounds have been proposed. First,rationalize the activities; then select evaluation points; and after that, examine the impact of the choices made in terms of alternative follow-on actions.

The discussion has been concerned with processes, actions, and

activities, and this is important to remember. To keep the network and analysis simple, the user must not mix the "apples" of process with the "oranges" of organization. It will be insufficient to show an element of the network representing only some organizational entity. The chart must show the action that entity is expected to accomplish.

In using the network concept, we must decide whether or not to try to include the use of resources in it. It is not absolutely necessary to have indications of how much money, time, or technical expertise are to be consumed in the processes portrayed. However, without some indications of resource usage on the network, its usefulness will be severely limited. The consideration of resources is the fourth step in the application of SNAP.

Time usage is easily shown. First, calendar dates may be shown next to each action rectangle. The date of a completed evaluation or decision may be shown at the output point of the decision diamond. The arrows which connect the chart elements may have lengths proportional to the time consumed by the activity from which they emanate. It is also possible to superimpose the whole network on an overall time scale in the manner of milestone charts.

Expertise and technical resources may be shown as inputs. More often than not this will not be required if the action items show the agency which will carry them out. This leaves some room for implication and assumption, but with a defined work package the expertise tends to be fixed. As was the case in the integration experience recounted earlier, the application of resources may be

an action to be evaluated in the process. It is important in this type of evaluation to spell out the steps and possible results in some detail. This will enhance the communication and motivation value of the SNAP which will be covered later.

SNAP is supposed to be simple. When addressing the money resource, the goal of simplicity must be given some priority. Experience with SNAP does not indicate any way to show easily the use of funds. But, when time and technical resources are known, the money requirement can be computed. Not showing funds is less a drawback than it seems. For a well defined task or constrained time period, a certain amount of money is allocated from the next program level. SNAP is designed to aid the manager in determining the course to be followed within such constraints. On the other end of the task/time definition spectrum, SNAP is a tool in determining the funding level requirement. Thus, the money requirement becomes, respectively in these two extremes, either an input or an output of the application of SNAP. One more point on funds: the visibility of decisions and alternatives is a real and important advantage when the manager faces an increased constraint in mid-program.

There are then, overall, five steps of consideration in the SNAP technique:

(0) Consider current situation, inputs, and objectives.
(1) Formulate processes and actions.
(2) Select evaluations and decision points.
(3) Develop continuance, exploitation, and corrective alternatives.
(4) Give visibility to resources as necessary.

Since SNAP is graphic, some words on mechanics are necessary. Keeping in mind that SNAP has to be kept simple to encourage the exploration of alternatives in non-linear processes, what follows is less a set of rules and more a list of triggers designed to allow the exercise of imagination. In this regard, the manager who expects to use SNAP ought to draw it himself. The graphic network is nothing more than a visual presentation of the abstract network in the manager's mind. The network allows him to visualize it better and lets other people see it more clearly.

Users who begin to think of ways to use computers to execute the SNAP presentation or to mechanize the analysis have moved too far into the realm of sophisticated techniques. Only after sound application of the five considerations is such an extension of SNAP wise. Remember, the idea is to have a simple tool and to restrain it to that level where manual implementation is sufficient. If this is not done, the user must wait some period of time to visualize his abstract action plan, because some machine must operate on it. Immediate feedback and its stimuli are lost, and linear disease sets in.

For the actual portrayal only three primary symbols are suggested. The action rectangle in which the process step or activity is described is probably familiar. Arrows which are connectors and also indicators of the flow direction are used in conventional ways. The third and most important symbol is the decision diamond. It indicates how and where an evaluation has been done and where alternatives may be selected. The evaluation process may be shown as an action rectangle input to a decision or within the decision diamond, depending

on the complexity of the choices and comparisons.

It may turn out that in the process flow the outputs of more than one decision diamond may lead to the same alternative. Use of a circle as a connector is suggested when this happens, so that the alternative process need be drawn only once. When showing time in this type of alternative, the start date would be "D-Day". This is done since the process may be entered at different times depending on which decision diamond leads into it.

Figure 5, on the next page, is an example of the application of SNAP to a common problem. It will demonstrate the considerations and mechanics which have been outlined here. The task of writing a research paper for a college course is analyzed as follows:

STEP 0: The objective is to write an acceptable paper on a topic chosen by the writer/student. The college has certain rules of an administrative nature which deal with format, etc. The paper must be completed in a given time period, 16 weeks. Outstanding papers may be published in a college organ.

STEP 1: The major activities are,
- -select a topic
- -select a faculty advisor
- -plan the approach, objectives, and content
- -do research
- -write the paper
- -obtain administrative support(typing & editing)

STEP 2: The evaluations and decisions are,
- - is the combination of topic,advisor, and plan acceptable?
- - after research, is there enough information for the report?
- - based on the final plan, is the report draft acceptable?

STEP 3: The alternatives are,
- - for the combination of topic, advisor, and plan there are several alternatives within the rules.

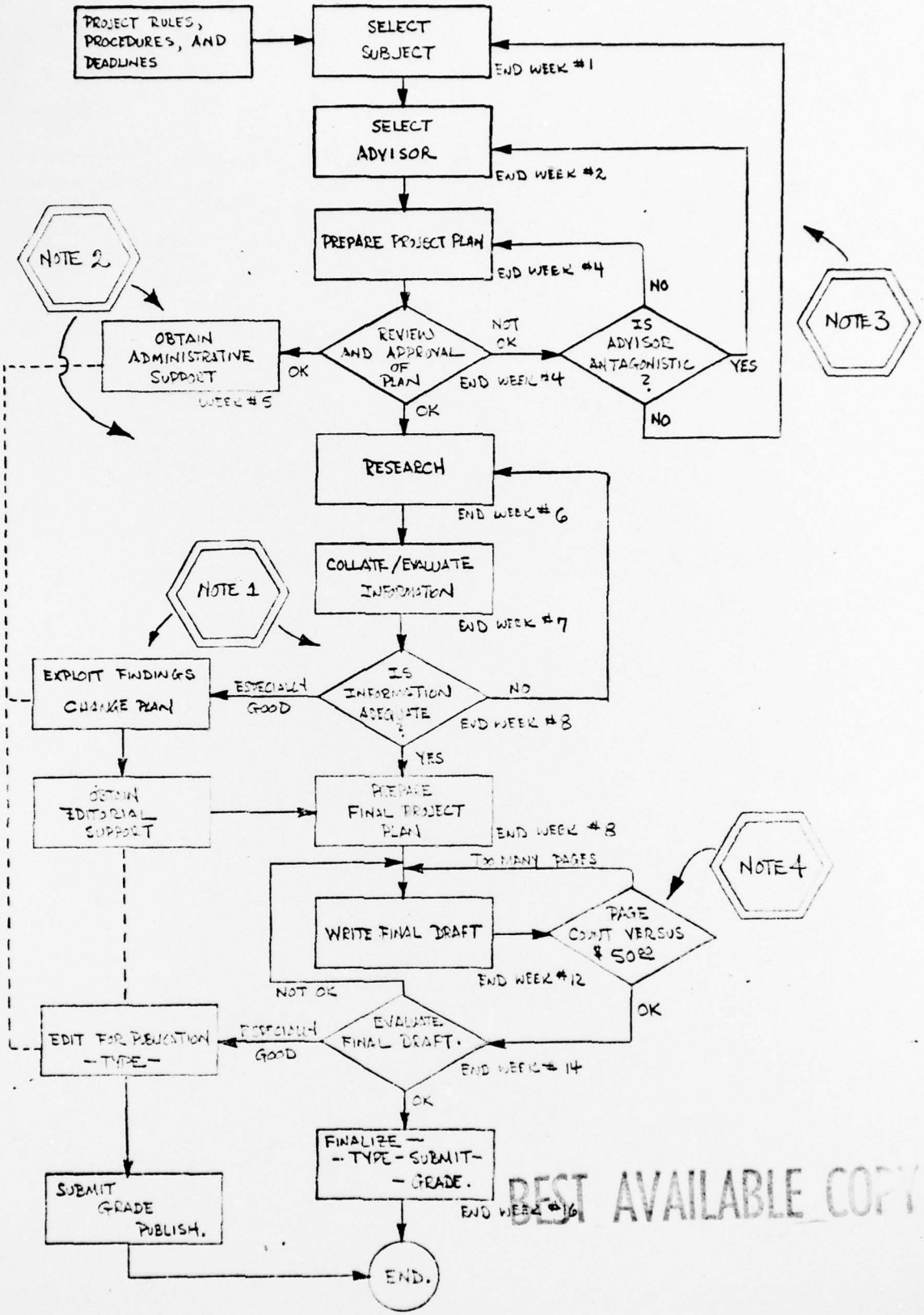


FIGURE 5 SNAP APPLICATION TO RESEARCH PAPER PROJECT

These have to do with the type of report and sources of research material and technique. All are to be reflected in the project plan and all are dependent on the others. Therefore, when the plan is evaluated all are considered. Not considered is the subjective disagreement between the student and the advisor about these interrelationships. There is early in the process an alternative of selecting another instructor as advisor. As we look at the plan, it may result in some extremely valuable research beyond that originally conceived. This may require special administrative support for publication. In any case some administrative support may be required.

- as research is done and information is gathered it must at some point be evaluated to see if there is enough to support the plan. Either there will or there won't with continue as planned or do more research being the respective alternatives. In some cases there may be some especially good information which will allow quicker completion of the paper or produce a more valuable outcome. Either would require a change in plan for exploitation. All three alternatives require a finalization of the plan.
- The final plan is followed by writing and evaluating the draft report. It is measured against the plan. If it is publishable it would be edited then graded and the project would be completed. If it were not so outstanding it would be graded and that would end the project.

STEP 4: The resource consideration are,

- expertise and time are accounted for. The writer is the major technical input. Time is shown by annotating the elements of the network. There is one other resourse to consider. The student/writer has only $50.00 to pay for typing and the cost will depend on page count. In the evaluation of the draft report the number of pages must be limited. Alternatives here are proceed if the cost is okay and rewrite for reduction if they are exceeded or add more if this is within reason(cost).

A few points are noted on the example. NOTE 1: Decision points and exploitation routes are shown. NOTE 2: The parallel activities associated with obtaining administrative support are shown outside the main process. This could save time. NOTE 3: Dangerous and time-

consuming negative loops are shown. NOTE 4: Dependent evaluations are shown. The SNAP shows the process that the writer must go through to finish his paper. It adds to the linear schedule the alternatives which could result in schedule problems and which would produce a more valuable report.

The considerations are basic, the mechanics are simple, and the presentation is manual. The key is to balance the tendency to think tasks are too simple to analyze against overcomplicating the issues. Always looking for multiple outputs from properly done evaluations will achieve this balance. It is now possible to reflect on the uses that have been implied and some extensions of SNAP which seem feasible. This is the thrust of the next section.

SECTION VI

UTILITY

Networks have been most widely associated with the planning and control functions of management(12:461). SNAP, as suggested here previously, is also best applied in these areas. As has been emphasized, the network is only a graphic manifestation of the analysis that it represents. Modern writers suggest that managers achieve results through other people(11:30). If this is true, then managers must know what must be done; must tell others their views of the task and get the doers to agree with these views; and then they must check, channel, and control progress toward the objective of the task.

The graphic network finds its utility in all these areas of management activity. It does to a great extent provide a mechanism for integrating them. First, the manager uses the network to lay out his plan as a step by step process. The use of evaluation and decision junctions in the network exposes non-linearities which can be exploited or dealt with depending upon their overall effect. There is increasing recognition that planners must consider alternatives as early as possible(6:46-52). While SNAP is oriented to middle, coordinative, management, spin-offs from their exposure of alternatives and trade-offs are likely to be helpful to top managers and strategic planners (12:437-438). The basic utility of the network is the potential to uncover the true and complete interrelationship of all process parts. This leads to more complete plans that are practical. It might also show that there are many acceptable future courses. When strategic level managers use SNAP, it may reveal the necessity of not choosing

exactly what to do. There appears to be some positive value in being vague as long as all the implications have been taken into account(12:442).

Modern managers are less authoritative when the tasks at hand and the means to final objectives are less than clear. The overall technical systems which are being managed are often too complex for anyone to know what is precisely right. The manager, at any level, must draw in the expertise needed to fill gaps in his own knowledge and experience. He must obtain the cooperative participation of others in his decision processes. For this he relies on effective communication with the people on whom he depends. SNAP is a concise vehicle that the manager may use to present analyses and plans. If he maintains the proper attitude about two-way communications, his graphic presentation should draw in ideas, suggestions, and questions from his team.

Once a plan is agreed upon, it must either be followed or changed to meet something unforeseen. The continuing process of executing planned actions and comparing results with desired outcomes is the essense of the executive role of the manager. Control is the major function of this role. SNAP is a mapped route against which the executive tracks progress. Workable networks which are demonstrated to be traceable are confidence builders. As the manager and his team proceed, they can determine the correctness of the plan and predict how good the rest of the network is. If evaluations and alternatives are present, as they must be in SNAP, periodic checks are built in and everyone knows where they are. Also, the alternatives will show

where to go if one course does not work out as planned. There will be cases when the network will show an alternative which is essentially "start all over again, success is impossible". It is extremely important to gain visibility into this kind of situation. It leads to the early recognition of problems and, more importantly, lets the entire team above and below the manager know of that particular eventuality.

This leads to consideration of SNAP as a motivation device. A combination of effects operate here. To move ahead competently, everyone needs to know where he wants to go, where he is, and if he is making any progress(14:154-155). Knowing these answers, he has a basis for motivation feedback. The planning and control aspects of SNAP assist in knowing these answers. Another part of motivation is perceiving a need to take an action. The visibility of activity interactions found in SNAP allows every team member to see how he fits and why his effort is important. Finally the network shows the consequence of success and failure. Any good SNAP will show fall-back alternatives and, yes, even an alternative for complete stopping of the effort. It is to be expected that everyone will be able to see how this could happen, and all should be inclined to work to keep off the cancellation path.

SNAP is a useful mechanism for integrating planning and control. It enhances the excutive role of the manager in the control function. It is appropriate to end our formal presentation with a comment on people the only real reasoning resource. SNAP is good for people, because it aids communication and motivation. As a tool it has wide utility and it is easy to use.

SECTION VII

CONCLUSION

The simplified network analysis portrayal, SNAP, has been presented as an approach only slightly more complex than the well known Gantt Chart. Key elements are the considerations of evaluation actions and decision points during the formulation of activities expected to lead to some objective of concern to management. In the planning of the process to be followed these considerations lead the manager to an appreciation of alternatives which follow as a result of evaluations and decisions.

Experiences in two major projects showed how SNAP was actually applied. In both these cases success was achieved where failure had been previously experienced, and SNAP was the principal aid used.

SNAP was shown to be a rational approach to develop and to communicate the manager's mental abstraction of the course of action he wants to follow. Simplicity is an important factor. Simple ideas find wider acceptance, ease general understanding, and cost less in resources. Manual execution is suggested, and the user should be the creator.

Any level of management will find SNAP useful, because all levels become coordinative in certain environments. SNAP aids in planning and control and in the general areas of communication and motivation. SNAP like other management tools must be tailored to the application at hand. SNAP has great potential as an aid to integration and program balance, two principal concerns of modern managers of complex systems.

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NOTE: Sources marked with a star(*) have not been cited in the text of the report. They are listed to give views on the more common network techniques as seen from the middle management level.